Human Health Risk Assessment Scope for the Wolverine Clean Energy Venture (WCEV) (PTI Application # 317-07)

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This paper provides a brief summary of the human health risk assessment elements that have been included for the WCEV proposed permit, including a description of the findings of a cumulative risk assessment.

Under the Air Pollution Control Rules, Part 55 of the Natural Resources and Environmental Protection Act, the proposed emissions of the facility were evaluated by comparison of the project's modeled maximum ambient air impacts to the applicable health risk-based screening levels. This is the standard and required level of air toxics risk assessment under the New Source Review program, and typically, that is the extent of the risk assessment scope. For the WCEV application review, additional risk assessment steps were also performed, utilizing appropriate environmental modeling tools and risk assessment guidance.

The AQD performed an assessment of the net increase in lead air emissions and deposition impacts, and the multipathway impacts to children's lead exposure and blood lead levels. That was done in a "cumulative" approach, in that the potential background levels were accounted for. The results are presented in Sills and Sadoff (2008). That assessment was supplemented by additional analyses of the potential lead impacts (Sills, 2008a). All of the assessments focused on the potential impacts to children, who are a particularly susceptible subpopulation, and they accounted for potential background and multipathway sources of children's lead exposure.

The potential impacts of the proposed facility's mercury emissions were also characterized via risk assessment. At the request of MDEQ, the applicant provided a human health risk assessment of the proposed facility-wide mercury emissions and impacts to fish mercury levels and to the sport anglers who may eat their catch. The results are presented in WCEV (2007). Those incremental impact estimates should be considered in the overall context of the potential background levels of mercury in local water bodies, as discussed in WCEV (2007). Sills (2008b) summarizes the mercury modeling results of WCEV (2007) and presents some alternative modeling inputs and outputs.

Additionally, AQD staff evaluated potential concerns for human health risk from the simultaneous exposure to the complex mixture of air toxics in the proposed emissions. That assessment is described below.

Cumulative risk assessment

The cumulative risk assessment "additivity assessment" approach utilized was based on the screening-level approach described in Sills et al. (2008). The focus of the assessment was the modeled maximum ambient air impact for each substance. As noted above, the

maximum ambient air impact of each individual air toxic substance was compared to the applicable health risk-based screening level. In the "additivity assessment", all those substances which had an impact that was at least 1% of the screening level were initially assumed to act additively for the purposes of evaluating potential noncancer and cancer effects. Further details of the additivity assessment are provided below, for noncarcinogenic and carcinogenic effects.

Cumulative noncarcinogenicity risk assessment

The Hazard Quotient (HQ) for a substance is calculated by the environmental level of interest (e.g., ambient air impact) divided by the health-protective benchmark level (e.g., the Initial Threshold Screening Level (ITSL)). The total Hazard Index is the sum of all HQs, regardless of whether or not the substances have a common target organ or toxic effect. The screening step of excluding from the additivity calculation all substances with HQ values of < 0.01 reduced the list of substances to those in Table 1 below.

Table 1. Additivity assessment of noncarcinogenic air toxics

Substance	Applicant's HQ[1]	AQD's HQ[2]	Target organ / effect[3]	Comments
Acrolein	0.02	0.024	Irritation	
HCl	0.58	0.058	Irritation; respiratory	
HF	0.22	0.229	Irritation; respiratory	
Ammonia	0.015	0.015	Irritation; respiratory	
Sulfuric acid	0.19	0.19	Respiratory; irritation	
Beryllium	0.14	0.14	Respiratory	Subpharyngeal
Chromium (+6)	0.032	0.036	Irritation	
Cobalt	0.01	0.01	Respiratory	
Manganese	0.13	0.136	CNS	
Selenium	0.018	0.018	Irritation; respiratory; CNS; GI	CNS = headaches
Vanadium	0.14	0.14	Irritation; respiratory	Utilized the ITSL for vanadium pentoxide
Mercury[4]	0.00012	0.00012	CNS	See note #4
Lead[5]	0.0057	0.001	CNS	See note #5
TOTAL	**Total HI = 1.475 ~ 1 (see note #6)**	**Total HI = 0.996 ~ 1 (see note #6)**	**all**	**See note #6**

1. The applicant (Table 6-17, 12/4/07 update) provided the maximum ambient air impacts and comparisons to AQD screening levels. The Hazard Quotient (HQ) is the value resulting from dividing the maximum ambient air impact by the health risk-based protective benchmark level (the ITSL). ITSL = Initial Threshold Screening Level. The ITSL is the concentration of a substance over a specified averaging time which is protective against noncarcinogenic effects, as derived according to the Air Pollution Control Rules.

2. These HQs are based on the same ITSLs as applied by the applicant, but the maximum ambient air impacts were from AQD modeling (Jim Haywood, 1/4/08 modeling report for air toxics).

3. The target organ / effects of "irritation" and "respiratory" may overlap for some substances; "irritation" may include irritation to the eyes, nose, throat, or skin.

4. For mercury, the applicant (WCEV, 2007) provided a modeled maximum ambient air concentration of 3.61E-05 ug/m^3 (with annual averaging time) for total mercury. That impact was divided by the EPA Reference Concentration (RfC) for elemental mercury (0.3 ug/m^3). The resulting HQ is for inhalation-only exposure; multipathway exposure and risk is addressed in WCEV (2007) and Sills (2008b). The HQ presented here is well below the 0.01 criterion for inclusion, but is presented here for clarity and completeness.

5. For lead, the AQD modeled ambient air impact for residential areas was 0.0001 ug/m^3 (annual averaging time; Sills and Sadoff, 2008). The applicant's modeled maximum impact was 0.00057 ug/m^3 (monthly averaging time; Caudell, 2008). Lead is not an air toxic, therefore there is no ITSL. The National Ambient Air Quality Standard for lead is currently 1.5 ug/m^3. However, EPA (2008) has proposed revising the standard to a value in the range of 0.1 to 0.3 ug/m^3, and has solicited comment on an averaging time of monthly or calendar quarter. For the purposes of this additivity assessment, the modeled ambient air impacts listed here were compared to the low-end of the EPA proposed NAAQS range (0.1 ug/m^3), without attempting to adjust for the differences in averaging times. The HQs presented here are well below the 0.01 criterion for inclusion, but they are presented here for clarity and completeness. Multipathway lead impacts are addressed in Sills and Sadoff (2008).

6. As a screening step (Sills et al., 2008), the sum of all HQs can provide a "Total Hazard Index (HI)". This is a conservative screening approach, without the appropriate separation of substances and HQs according to the commonality of the target organ or critical effect.

Consideration of "background" levels of air toxics can help to lend perspective to the source impacts. However, this is limited by the lack of ambient air monitoring data for the area. The EPA 1999 National Scale Air Toxics Assessment (NATA) provides estimates of hazardous air pollutant concentrations, based on emissions estimates and dispersion modeling. The NATA estimates were developed for risk management considerations and not for direct regulatory applications, and are now somewhat dated (1999). They may still serve as a useful general guide to the background air toxics concentrations and risk levels for cumulative risk assessment. Information was obtained from the EPA's NATA website (http://www.epa.gov/ttn/atw/nata1999/) and from Palma and Strum (2005). For noncancer effects, the focus of the available summary information is on the cumulative HIs for respiratory and for neurological effects. The counties of Michigan have median (across census tracts) respiratory HIs ranging from less than 1 to the 5-30 range. Presque Isle County (the location of WCEV) is in the 0-1 range. The Risk Maps available at the NATA website indicate that the respiratory HI for the WCEV area is approximately 0.55-0.57, predominantly due to on-road, non-road, and background sources sources, and specifically, acrolein concentrations. It may be noted that the acrolein HQ was based on the Reference Concentration (RfC), which was based on a rodent study and incorporated an uncertainty factor of 1000. This helps to indicate the lack of precision, and considerable uncertainty, in the RfC, HQ, and HI values. The NATA-based neurological HI for the WCEV area is approximately 0.024-0.029, primarily due to area sources (i.e., non-major point sources).

As shown in Table 1, the total HI for the WCEV project is approximately "1". From the data in Table 1, target organ-specific hazard indices (TOSHIs) for irritation and respiratory effects are calculated to be approximately "1" based on the applicant's impact estimates (rounded to one significant figure); they were 0.7 and 0.8, respectively, based on the AQD modeled impact estimates. These values do not raise particular concerns for the potential cumulative impacts of the complex mixture, for the project alone or in consideration of potential "background" air toxics concentrations based on the limited information described above.

Some of the criteria pollutants emitted by WCEV (SO_2, NO_x, and PM-10) are respiratory tract irritants. Although the EPA does not evaluate cumulative exposures and risks for the criteria pollutants, the total ambient air concentrations for each of these may be summarized as follows:

Substance	Total impacts[1] as % of NAAQS[2]		
	3 hr. avg. time (AT)	24 hr AT	Annual AT
SO_2	8.1%	11.5%	4.8%
NO_x	-	-	9.1%
PM-10	-	85.9%	55.1%

[1] Total impact includes WCEV, other sources, and the area background.
[2] Based on the AQD Air Dispersion Analysis Summary by Jim Haywood, 1/4/08 completion date.

Some of the Table 1 substances are CNS toxicants. Although the HQ values for these substances in Table 1 do not indicate a concern, individually or cumulatively, these HQs address only inhalation exposure. As indicated previously, the multipathway impacts, exposures and risks of mercury and lead are discussed in detail elsewhere. Although it is possible that lead and mercury exposures, in general, could have cumulative multipathway effects on the CNS, the detailed assessments indicate that the facility incremental impacts are very small. Those assessments also indicate that the "background" exposure sources (for mercury, due to fish consumption; for lead, due to oral exposure to deteriorated house paint containing lead) may be substantial. These potential exposure situations do not indicate that the WCEV emissions and impacts would be reasonably anticipated to pose a significant cumulative risk for CNS effects alone, in combination, or in the aggregate including potential background sources.

Cumulative carcinogenicity risk assessment

As with the assessment of noncarcinogenic effects, this additivity assessment utilized a screening criterion of 1% of the screening level to help focus the assessment on the substances that may make a substantive impact on the total risk. The screening level utilized for the screening was the Initial Risk Screening Level (IRSL), which is the ambient air concentration that is associated with an upper-bound cancer risk estimate of 1-in-one million (i.e., 10^{-6}) to an individual with a lifetime of exposure. Therefore, Table 2 includes only the emitted carcinogenic substances with a modeled maximum ambient air impact that is associated with a risk level of at least 1% of the IRSL (i.e., a risk of at least 1-in-100 million). The modeled ambient air impacts were provided by the applicant (WCEV, 2007), and by AQD (Jim Haywood; 1/4/08 completion date). The results are presented in Table 2.

Table 2. Additive cancer risk estimates of WCEV project emissions.

Substance	**Risk estimates (plausible upper-bound)**	
	Based on applicant's modeled impacts	**Based on AQD's (1/4/08) modeled impacts**
Methyl hydrazine	1.9E-7	1.91E-7
B(a)P and combined PAHs	2.7E-8	2.7E-8
Naphthalene	2.4E-8	2.4E-8
Benzene	1.E-7	1.E-7
Benzylchloride	1.9E-8	2.E-8
1,3-butadiene	1.5E-8	1.5E-8 (applicant's value)
Formaldehyde	1.3E-7	1.38E-7
Arsenic	2.4E-6	2.49E-6
Beryllium	4.1E-7	4.25E-7
Cadmium	2.2E-7	2.23E-7
Chromium (+6)	3.5E-7	8.43E-7
Nickel	1.4E-7	1.43E-7
2,3,7,8-TCDD – TEQ	1.2E-7	1.22E-7
TOTAL	**Total cancer risk = 4.1E-6 ~ 4 in 1 million**	**Total cancer risk = 4.7E-6 ~ 5 in 1 million**

The background total cancer risk estimates provided by EPA's NATA 1999 study can help lend perspective to the source impacts. These indicate that the air toxics levels in counties in Michigan pose an estimated median (across census tracts) cancer risk ranging from the 0-1 in one million range to the 50-75 in one million range. Presque Isle County and the other counties in the northern lower peninsula are in the in 1-25 in one million range (Palma and Strum, 2005).

There are no AQD rules or criteria for the acceptability of total (cumulative) cancer risk, for ambient air background levels or for source impacts. In the opinion of the author, the total cancer risk estimates associated with the WCEV project do not raise particular concerns for cumulative risk.

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